

# Development of a model simplification procedure for integrated urban water system models – catchment and sewer conceptual modelling

Leila Pieper

Julia Ledergerber, Adrien Comeau and Peter A. Vanrolleghem

Prague, Czech Republic, September 13, 2017



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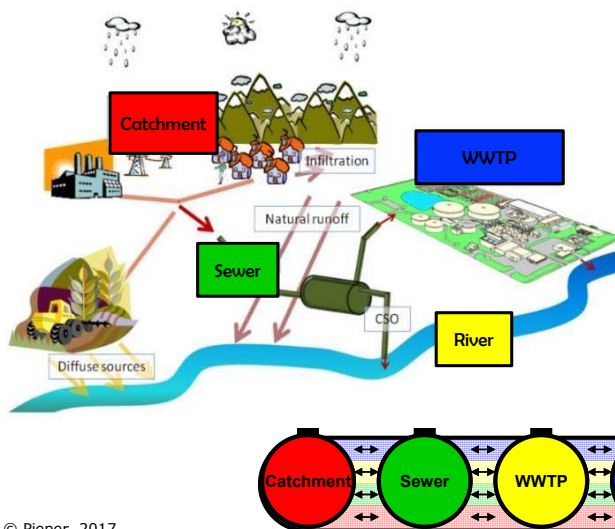
## OUTLINE OF PRESENTATION

1. Context
2. Objectives
3. Methodology
4. Developed procedure
5. Model results
6. Conclusions

# 1. CONTEXT

## 1. CONTEXT

### Integrated urban wastewater system (IUWS)



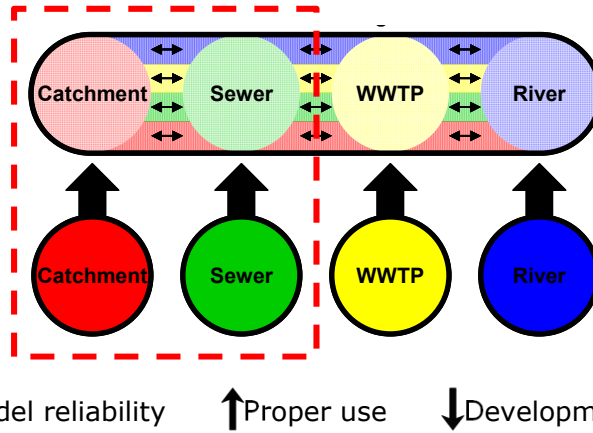
#### Model uses:

- Water quality modelling
- Multi-objective optimization
- Control strategies
- Uncertainty analyses

## 1. CONTEXT

### Problem Statement

“No clear procedure exists to represent catchments and sewers in integrated models”



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## 2. OBJECTIVES

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## 2. PROJECT OBJECTIVES

1. **Understand the current approaches** used to develop conceptual representations of hydrologic and hydraulic models
2. **Establish a procedure** for the development of a conceptual IUWS model from detailed models
3. Consider the **specific needs of a case study** by developing the procedure using a case study
4. **Compare the accuracy and simulation time** of the conceptual models to the detailed model

## 3. METHODOLOGY

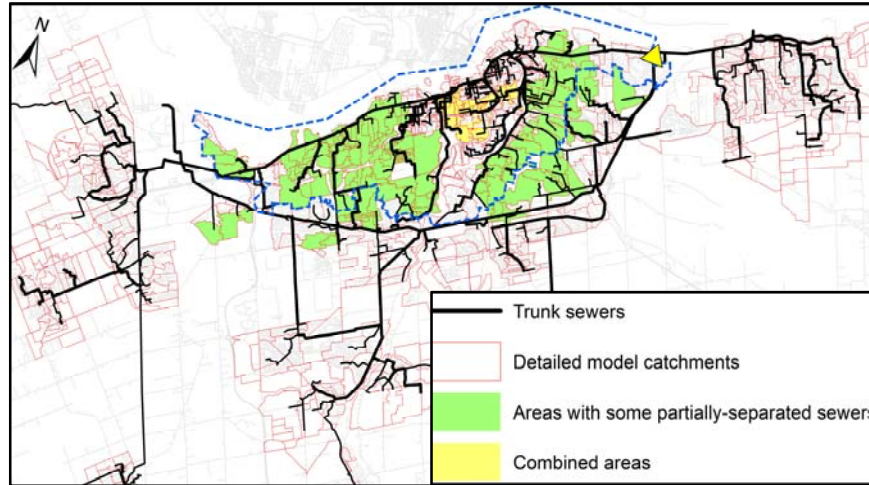
### 3. METHODOLOGY

- I. **Literature review** of current IUWS modelling approaches
- II.  **Software** suitability & development
  - Increase flexibility of DWF/WWF routing in catchments
- III. **Developing the conceptual modelling protocol** by building 2 models with increasing level of aggregation

## 4. DEVELOPED PROCEDURE

## 4. DEVELOPED PROCEDURE

### Ottawa case study - Detailed model



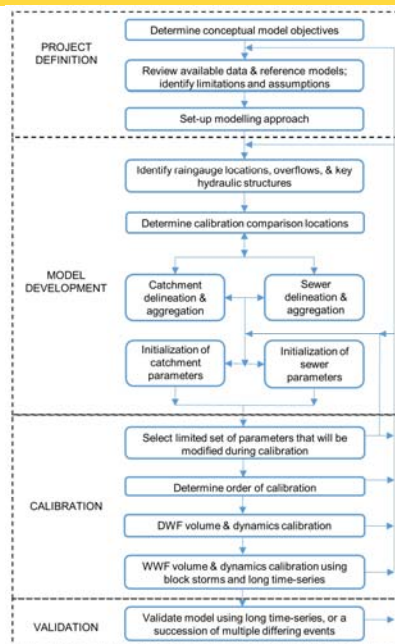
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## 4. DEVELOPED PROCEDURE

### Overview

- I. Project definition
- II. Model development
- III. Calibration
- IV. Validation



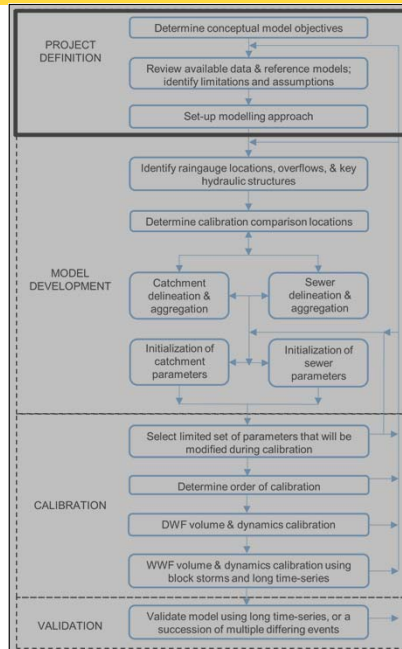
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## 4. DEVELOPED PROCEDURE

### Overview

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## 4. DEVELOPED PROCEDURE

### I. Project definition

1. Model **objectives**
  - Represent flow in trunk sewers & OVFs
  - Meet pre-defined criteria
2. Understanding the **system**
  - Available data and reference models
  - Limitations & assumptions
3. Setting-up **modelling approach**

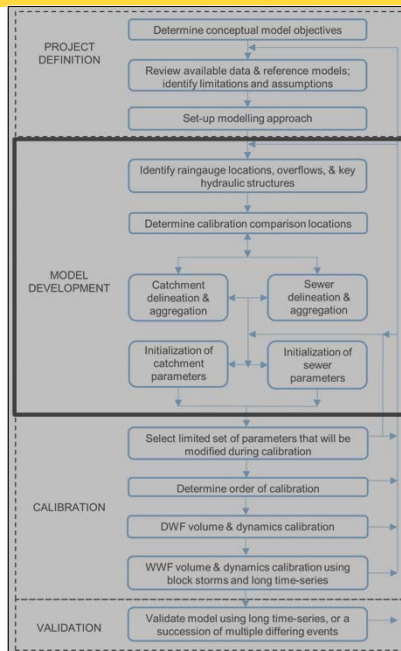
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## 4. DEVELOPED PROCEDURE

### Phases

- I. Project definition
- II. Model development**
- III. Calibration
- IV. Validation



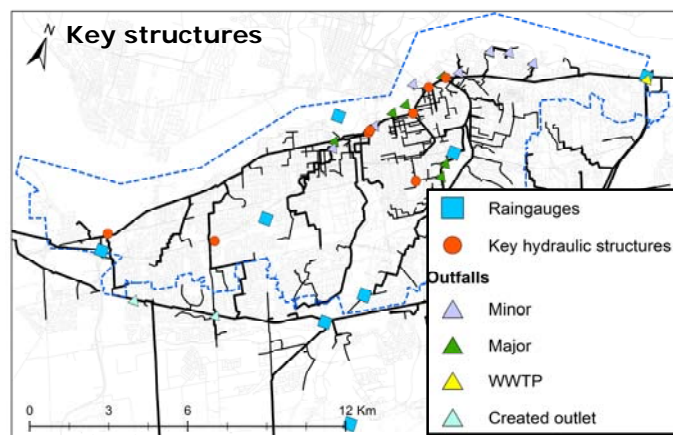
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## 4. DEVELOPED PROCEDURE

### II. Model Development

1. Determining calibration **comparison locations**
2. Catchment & sewer **delineation and aggregation**



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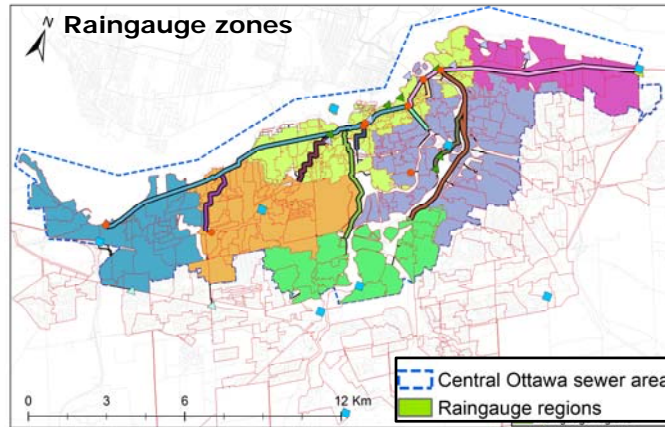
16



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### II. Model Development

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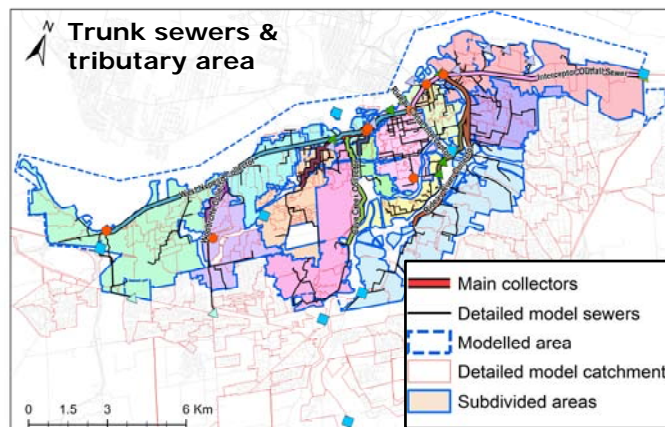
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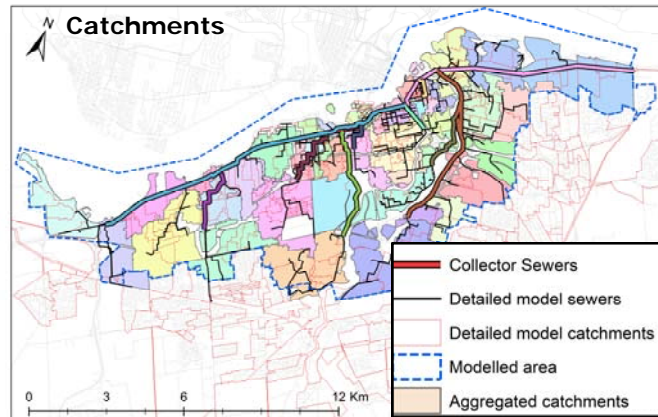
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## 4. DEVELOPED PROCEDURE

### II. Model Development

1. Determining calibration **comparison locations**
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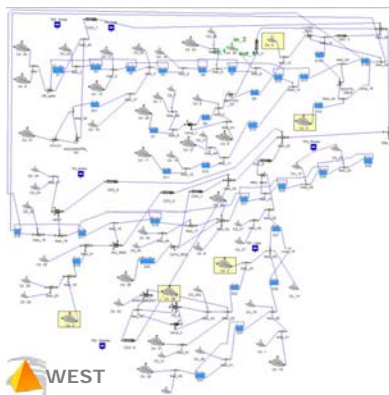
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## 4. DEVELOPED PROCEDURE

### II. Model Development

1. Determining calibration **comparison locations**
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**Conceptual model**



**Further simplified  
conceptual model**

20

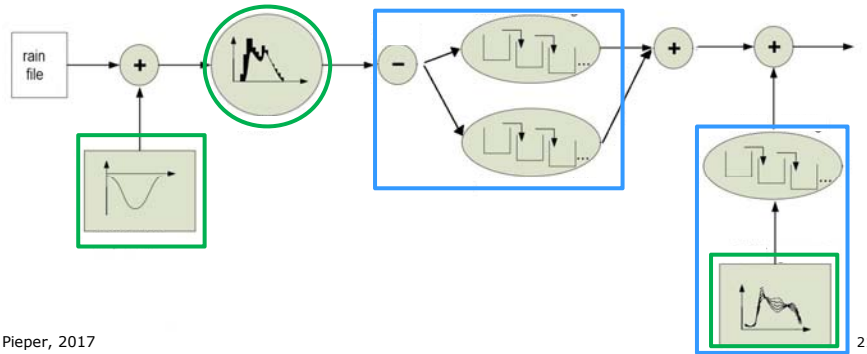
## 4. DEVELOPED PROCEDURE

### II. Model Development

#### 3. Convention for parameter initialization - catchments

- Parameter values:
- **ASSUMED**: from detailed model
  - **CALIBRATED**: combined effects

#### WEST Catchment model



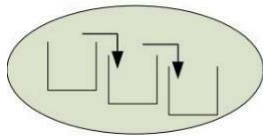
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## 4. DEVELOPED PROCEDURE

### II. Model Development

#### 3. Convention for parameter initialization - sewers

- Linear reservoirs: sewers with backwater



- Non-linear reservoir: other sewers



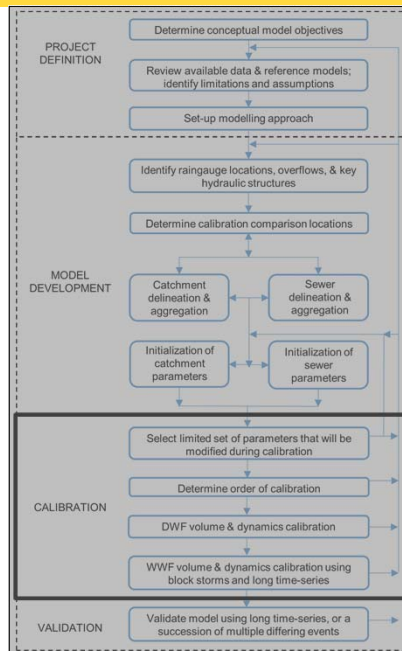
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## 4. DEVELOPED PROCEDURE

### Phases

- I. Project definition
- II. Model development
- III. Calibration**
- IV. Validation



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## 4. DEVELOPED PROCEDURE

### III. Calibration

1. Calibration criteria
2. Calibration order of components
3. Calibration runs & modifiable parameters
4. DWF / WWF
  - Volume
  - Dynamics

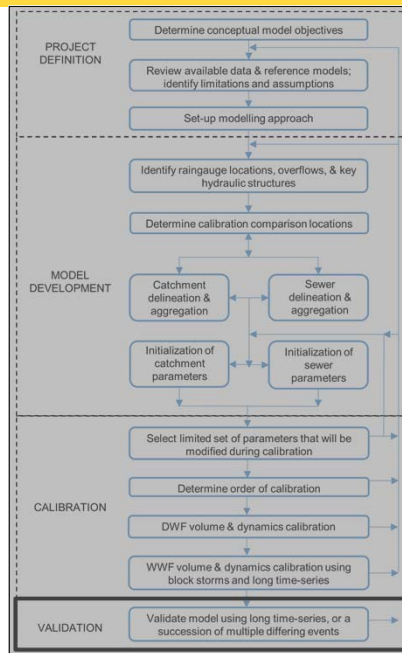
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## 4. DEVELOPED PROCEDURE

### Phases

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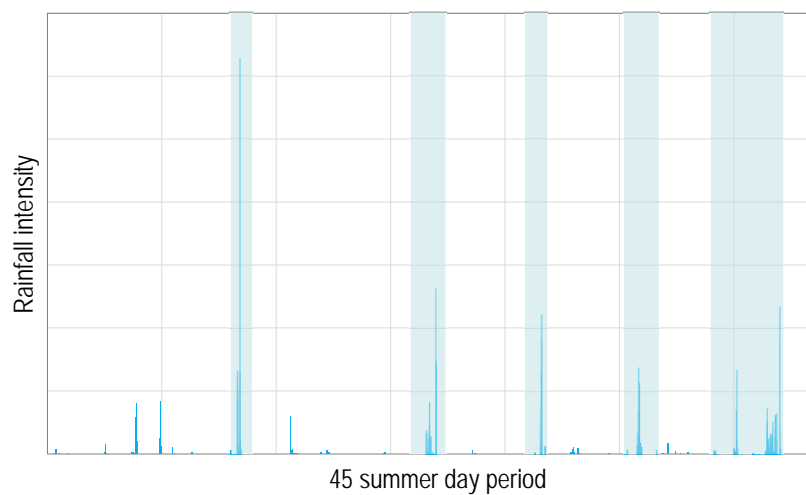


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## 4. DEVELOPED PROCEDURE

### IV. Validation – long time series



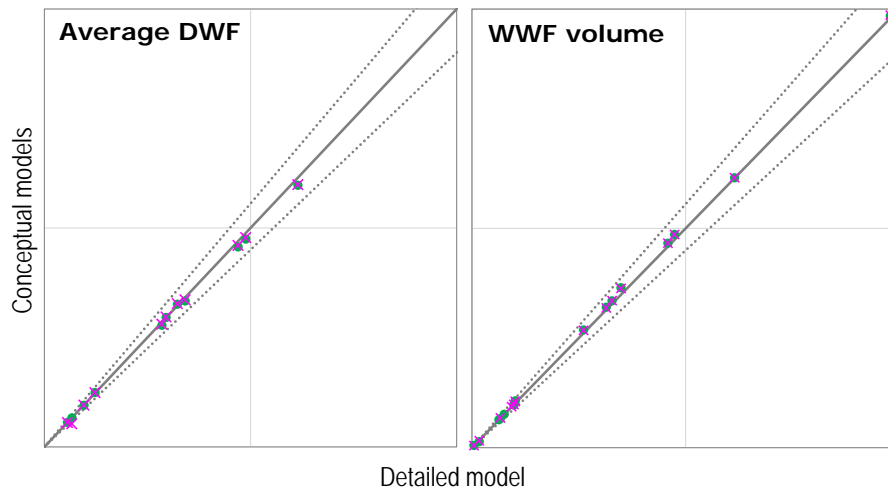
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# 5. MODEL RESULTS

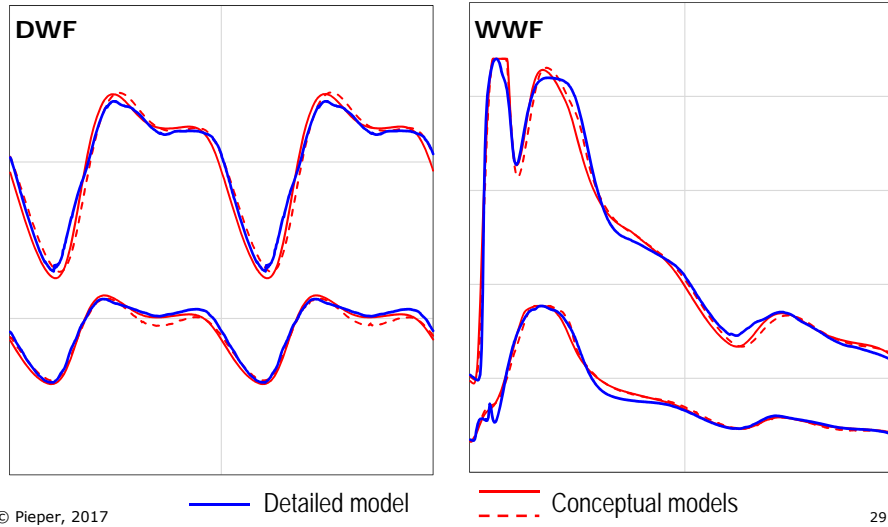
## 5. MODEL RESULTS

### DWF & WWF: 1:1 Graphs – Volume



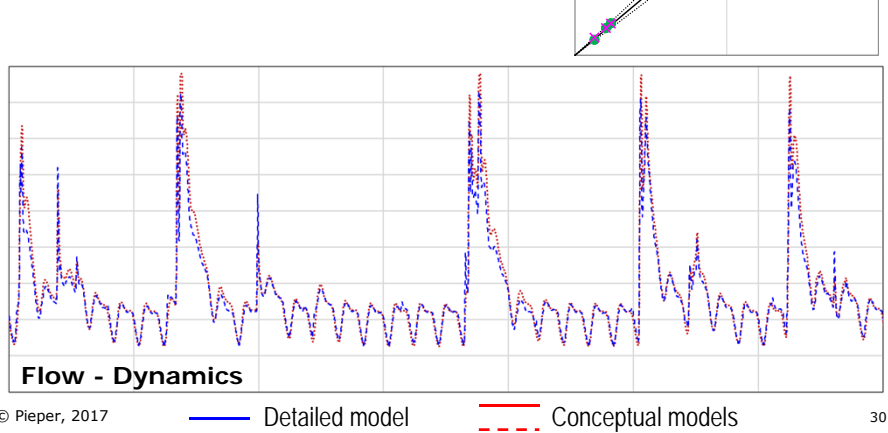
## 5. MODEL RESULTS

### DWF & WWF: Flow Hydrographs – Dynamics



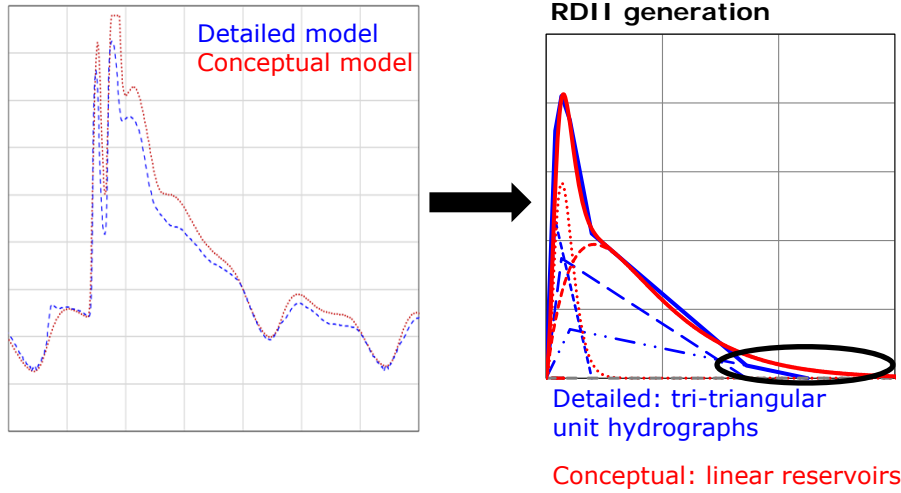
## 5. MODEL RESULTS

### Validation: Volume and dynamics



## 5. MODEL RESULTS

### Validation: Explanations for deviations



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## 6. CONCLUSIONS

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## 6. CONCLUSIONS

### Objectives

1. Understand current approaches
2. Establish procedure
3. Consider **specific needs** of case study
4. Compare accuracy and simulation time



### Findings

- Framework for procedure developed based on researched methods
- WEST software developed to better accommodate catchment and sewer representations
- Examples from case study included in procedure
- **Good quality simulations results** from conceptual models

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